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JOINT SPECTRUM ACQUISITION AND MANAGEMENT FOR THE 21ST CENTURY

by

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June 1999

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13. ABSTRACT Radio frequency (RF) spectrum is a limited, reusable resource. The next century's ownership of this resource, and the policies which guide its usage, are being determined today. The spectrum requirements needed for the realization of *Joint Vision* 2010 are in direct competition with similar commercial needs worldwide. This thesis outlines the fundamental agencies, regulations and policies that govern the acquisition and management of the radio frequency (RF) spectrum. An understanding of Department of Defense (DoD), national, and international procedures for frequency management is critical to military acquisition professionals involved in the planning of future systems.

This thesis will assist students and researchers at the Naval Postgraduate School in developing an understanding of spectrum management and acquisition policies as they relate to United States (US) joint military command, control and communications (C3) systems.

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JOINT SPECTRUM ACQUISITION AND MANAGEMENT FOR THE 21ST CENTURY

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ABSTRACT

Radio frequency (RF) spectrum is a limited, reusable resource. The next century's ownership of this resource, and the policies which guide it's usage, are being determined today. The spectrum requirements needed for the realization of *Joint Vision* 2010 are in direct competition with similar commercial needs worldwide. This thesis outlines the fundamental agencies, regulations and policies that govern the acquisition and management of the radio frequency (RF) spectrum. An understanding of Department of Defense (DoD), national, and international procedures for frequency management is critical to military acquisition professionals involved in the planning of future systems.

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LIST OF ACRONYMS AND ABBREVIATIONS

a.k.a.	Also known as
AFFMO	Air Force Frequency Management Office
AFMO	Area Frequency Management Office
AO	Area of Operations
ASD	Assistant Secretary of Defense
BSS	Broadcasting Satellite Service
C2	Command and Control
C3I	Command, Control, Communications and Intelligence
C4I	Command, Control, Communications, Computers and Intelligence
CD-ROM	Compact Disk – Read Only Memory
CECOM	Communications-Electronics Command
CG	Commanding General
CINC	Commander-in-Chief
CIO	Chief Information Officer
CJCS	Chairman, Joint Chiefs of Staff
CONUS	Continental United States
COTS	Commercial-Off-the-Shelf
DIA	Defense Intelligence Agency
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DISN	Defense Information System Network
DMS	Defense Message System
DoD	Department of Defense
E3	Electromagnetic Environmental Effect
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FAS	Frequency Assignment Subcommittee
FCC	Federal Communications Commission
FMO	Frequency Management Office
FRC	Federal Radio Commission
FRRS	Frequency Resource Record System
FSS	Fixed Satellite Service
GCCS	Global Command and Control System
GCSS	Global Combat Service Support System
GHz	Giga Hertz
GMF	Government Master File
GPS	Global Positioning System
HFBC	High Frequency Broadcast
Hz	Hertz

IFF	Information, Friend or Foe
IFL	International Frequency List
IFRB	International Frequency Registration Board
IRAC	Inter-Agency Radio Advisory Committee
IT	Information Technology
ITAF	International Table of Authorized Frequencies
ITU	International Telecommunications Union
JFC	Joint Forces Commander
JSC	Joint Spectrum Center
JV	Joint Vision
KHz	Kilo Hertz
LAN	Local Area Network
LF	Wide Area Network
MAG	Military Assignments Group
MCEB	Military Communications-Electronics Board
MEF	Marine Expeditionary Force
MF	Medium Frequency
MHz	Mega Hertz
MIFR	Master International Frequency Register
MSS	Mobile Satellite Service
NAVEMCEN	Naval Electromagnetic Center
NGSO	Non-Geosynchronous Orbit
NSA	National Security Agency
NTIA	National Telecommunications Information Agency
OMFTS	Operational Maneuver from the Sea
OSAM	Office of Spectrum Analysis and Management
OSM	Office of Spectrum Management
RF	Radio Frequency
SHF	Super High Frequency
TV	Television
UHF	Ultra High Frequency
UN	United Nations
US	United States
VHF	Very High Frequency
WAN	Wide Area Network
WRC	World Radio Conference

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EXECUTIVE SUMMARY

Radio frequency (RF) spectrum is a limited, reusable resource. The next century's ownership of this resource, and the policies which guide it's usage, are being determined today. The spectrum requirements needed for the realization of *Joint Vision* 2010 are in direct competition with similar commercial needs worldwide. This thesis outlines the fundamental agencies, regulations and policies that govern the acquisition and management of the radio frequency (RF) spectrum. An understanding of Department of Defense (DoD), national, and international procedures for frequency management is critical to military acquisition professionals involved in the planning of future systems.

A common requirement throughout the tenets of *JV 2010* and its subsequent service visions is the need for vast amounts of spectrum. This broad requirement demands not only the full utilization of existing and strained military spectrum, but also a marked increase in channelization if the bandwidth demands of *JV 2010*'s emerging technologies are to be met. Although this requirement is accepted and understood, it has largely gone unquantified. Much like many other commodities on the strategic battlefield, spectrum is resource that is limited and in high demand. The realization of *JV 2010*'s intent of "information dominance" relies on our ability to:

- Acquire the spectrum necessary for the employment of proposed systems
- Successfully manage and apportion the spectrum we control

In order to accomplish both of the above requirements, military C4I professionals first must gain an understanding of the complexities of national and international

spectrum allocation and assignment policies. This understanding will allow planners to design and acquire systems that can ensure uninterrupted operational capabilities.

The international and US policies defined by the ITU, the FCC and the NTIA provide the foundation for, and guiding principles of, our national military spectrum resources. Military relocation and the rapid acquisition of spectrum-dependent technology, combined with an insatiable demand for available frequencies from commercial industry, has brought the issue of Federal spectrum to the forefront of government debate. As within the civil sector, military IT assets are increasingly more efficient, less expensive, and have become heavily reliant on RF spectrum access. What was once a fixed, available, and transparent asset, routine military RF spectrum access has now become a precious, contentious commodity requiring active management and flexible long-range planning. Overseas, the worldwide realization of commercial spectrum opportunities has imposed unprecedented new restrictions on operational access. Despite the urgency, temptation, or level of conflict, a disregard for host nation (or even hostile nation) allocations is likely to result in potentially extreme and debilitating interference within US systems. Unlike most other natural and physical resources, spectrum can not be captured, commandeered, or subjected to rationing. Existing international commercial and civil assignments, particularly those that are space-based, are impervious to the needs of military operations. Due to their significant coverage and power, rather than challenged or ignored, these civil and foreign military assignments should be identified, respected, and avoided. Thus the need for detailed frequency management and analysis within the acquisition, strategic planning, and operational community is now more critical

to US military interests than ever before. Recent sweeping *Defense Reorganization Initiatives* have sought to streamline and consolidate the agencies and policies which address spectrum management.

In this new era of rapid Federal reallocation and regulatory change, acquisition professions and C4I planners are faced not only with new opportunities but with the potential for costly capability losses. Long-range planning, close coordination with the NTIA, and the exploration of commercial options will be essential in guaranteeing military users adequate spectrum for the realization of *Joint Vision 2010.*

State-of-the-art technological exploitation of the RF spectrum can hinge on antiquated treaties and allocations dating back to the dawn of international radio regulation. Operational military employment of the RF spectrum is an end-state made possible by a successful, dynamic and comprehensive management, assignment, and allocation process. These processes must be linked and carefully coordinated to ensure that appropriate spectrum resources are available when and where required, and that our equipment assets are configured to take advantage of this availability. To accomplish this, the DoD-unique *Spectrum Certification* process is required for all planned systems entering the acquisition cycle. The Spectrum Certification process is the Defense Department's principle means of ensuring that the required spectrum resources will be available when and where they are needed to support future operational requirements. Military acquisition professionals and contractors are ultimately faced with three choices for meeting the RF demands of their planned system:

(1) Utilize existing DoD allocated and approved spectrum in a traditional, assigned role

(2) Develop new frequency schemes that promise to not interfere with existing allocations and/or assignments

(3) Propose a change to national or international spectrum allocations and await resolution

The Spectrum Certification process is characterized by broad DoD guidance contained within the Federal Acquisition Regulations (FARs) and specific yet unique and disjointed Service regulations. Spectrum Certification for new DoD systems requires, at a minimum, US military, Federal, and limited international approval.

Expanding private sector needs, a dynamic regulatory environment, and targeted reallocations of Federal bandwidth are all significant factors to be considered by military telecommunications planners. For obvious reasons, the military Spectrum Certification process is now being reviewed and updated by all services and agencies involved in frequency management. As with acquisition reform, the military can no longer financially or operationally afford the long, inflexible, and arduous process of existing certification. For spectrum resources already allocated to military applications, a lack of active regulatory involvement could result in the proverbial "rug" being pulled out from under military assets assumed to be secure in their assignments and availability. Only through a comprehensive understanding of, and involvement in, the issues, proposals, and politics of national and international spectrum allocation will the military be able to achieve the spectrum resources required for the 21st century and *JV 2010*.

I. INTRODUCTION

A. BACKGROUND

1. Joint Vision 2010

a. The Need for Modernization

Military forces around the globe are facing the unprecedented challenges and opportunities posed by the arrival of the Information Age. Rapid, ongoing developments in both military and civil information technology (IT) capabilities have necessitated a fundamental shift in our design, acquisition, and employment of command and control (C2) systems. Key amongst these developments have been:

- The proliferation of the microcomputer
- The ability to distribute information through local-area and wide-area networks (LAN/WAN)
- Significant improvements in data transmission rates
- Military preferences toward commercially available, off-the-shelf (COTS) hardware and software
- Broad access to increasing amounts of satellite-based information

In order to provide a road map for the effective and focused migration of United States (US) command, control, communications, computers and intelligence (C4I) assets, the Chairman of the Joint Chiefs of Staff (CJCS) published *Joint Vision 2010.*

> Today, America's Armed Forces are the world standard for military excellence and joint warfighting. We will further strengthen our military capabilities by taking advantage of improved technology and the vitality and innovation of our people to prepare our forces for the 21st century. Joint Vision 2010 creates the template to guide the transformation of these concepts into joint operational capabilities [Ref. 1].

b. Service Visions

The US Army, Navy, Air Force, and Marine Corps have published subsequent service visions in response to *JV 2010*. In *Army Vision 2010*, the US Army predicts that "bandwidth on demand will facilitate common understanding at all echelons and new antenna configurations will allow dissemination of 'real time' information on the move." [Ref. 2] The Navy's *Copernicus* series is "the unifying vision to ensure C4ISR systems respond to the warfighter, are fielded quickly, capitalize on technological advances and support warfighting concepts." [Ref. 3] Concurrently, the Marine Corps has adopted *Operational Maneuver from the Sea* (OMFTS) and the C2 challenges it poses as the "transition from communications nets to information networks" [Ref. 4] is made. The Air Force's *Global Engagement* response to *JV 2010* recognizes the necessary migration of key military functions such as surveillance, reconnaissance, and communications from land and sea onto space-based platforms [Ref. 5].

c. Spectrum Demands of JV 2010

A common requirement throughout the tenets of *JV 2010* and its subsequent service visions is the need for vast amounts of radio frequency (RF) spectrum. This broad requirement demands not only the full utilization of existing and strained military spectrum, but also a marked increase in channelization if the bandwidth demands of *JV 2010*'s emerging technologies are to be met. Although this requirement is accepted and understood, it has largely gone unquantified. Much like many other commodities on the strategic battlefield, spectrum is resource that is limited and in high demand. The realization of *JV 2010*'s intent of "information dominance" relies on our ability to:

- Acquire the spectrum necessary for the employment of proposed systems
- Successfully manage and apportion the spectrum we control

In order to accomplish both of the above requirements, military C4I professionals first must gain an understanding of the complexities of national and international spectrum certification. This understanding will allow planners to design and acquire systems that can ensure uninterrupted operational capabilities. Equally critical is a network-wide realization of the technical skills required for innovative operational management of spectrum resources; skills which include collaborative planning and apportionment, network monitoring, and flexible, adaptive reassignment capabilities. A basic familiarization of RF regulatory history is helpful in order to understand the path that has led to our current spectrum acquisition and management processes.

2. Beginnings of Radio

Military usage of the RF spectrum in the US and abroad followed shortly after Marconi's successful wireless demonstration and patent award in 1896. Seeing the potential for maritime safety and strategic naval applications, the United States, under the leadership of President Theodore Roosevelt, quickly equipped twenty-four naval ships and ten coastal stations by 1904 [Ref. 6]. This initiative ushered in a experimental period of wireless telegraphy led largely in part by the United States military.

> The United States Navy is entitled to great credit for its part in the development of radio transmission. What private individuals or private electrical manufacturers may have dreamed about, the Navy technicians, with the resources of the nation behind them, were able to bring to pass [Ref. 7].

The opening days of World War I found German forces actively employing wireless technology as "the ether of the Channel was full of the smooth efficient wireless talk of her fleet as her ships

and their bases exchanged messages in intricate cipher…[Ref. 7]." Allied forces quickly adopted a similar embrace of radio and by 1916 the long-haul transmission of speech was demonstrated across oceans and continents. The war's conclusion in 1918 found that, although primitive, radio equipment common across land and sea had made its first indelible marks in the tactics, techniques, and procedures of modern warfare.

3. Regulatory History

a. The Dawn of International Regulation

The history of communications regulatory agreements can be traced to the 1865 Telegraph Convention, signed in Paris in 1865 [Ref. 8]. Long before World War I, international attention was directed at the necessity for the regulation of radio frequencies and equipment. In 1903, the First International Radio Telegraphic Conference was assembled in Berlin." [Ref. 9]. Ironically, this historic summit which included representatives from Austria, France, Germany, Great Britain, Hungary, Italy, Russia, Spain, and the US was convened to address commercial interoperability issues. The summit concluded with a draft agreement to establish an equipment protocol standard which would "ensure the exchange of messages without distinction as to the system of radiotelegraph used." [Ref. 9] The Berlin conference that followed in 1906 marked the beginning of *international* regulation of radio communications and spectrum allocation. Not unlike today's regulatory issues, this conference was again focused on standards, and more importantly, growing concerns over a world-wide market controlled by the then internationally unchallenged Marconi Company. The Conference's strongest supporters were the "executive departments of government including the Army, Navy and Department of Commerce and

Labor." [Ref. 9] Regular conferences followed, leading to the eventual establishment of the *International Telecommunications Union* (UTI) at the 1932 Madrid Conference. Today, the ITU is the oldest agency within the United Nations (UN) organization and has set an historical precedent of cooperation and assistance, "...insulated from the ebb and flow of world politics." [Ref. 8]

b. US Development of Domestic Radio Frequency Regulations

The Radio Act of 1912 represented the first US legislation addressing domestic spectrum allocation and provided separation between government, commercial and amateur wavelengths. By the mid-1920's, the advent of wide-spread commercial broadcasting created three major concerns within Congress: (1) vested rights in the spectrum, (2), the basis or criteria for granting a license, and (3) the monopoly of radio equipment [Ref. 9]. A Congressional review of the 1912 act resulted in the Radio Act of 1927 which created a five-member *Federal Radio Commission* (FRC). The FRC was charged with regulating the allocation of bands, assignment of power and issuance of licenses. The 1927 act also gave the Secretary of Commerce authority to "assign call signs, inspect radio stations, and examine and license radio operators." [Ref. 10]

The Communications Act of 1934 created today's clear separation between US governmental and commercial frequency regulation. This act, which is still in effect, created the *Federal Communications Commission* (FCC) for the regulation of interstate and foreign communications. The regulatory functions related to radio stations belonging to and operated by the US were conferred upon the President. The President's responsibilities were later transferred

to the Secretary of Commerce in 1978 and are today managed within the Commerce Department by the *National Telecommunications Information Agency* (NTIA).

B. WHAT IS SPECTRUM ?

Before the demands of modern military spectrum acquisition and management can be addressed, the bands within the RF spectrum, common usages, and spectrum terminology should be discussed.

1. Frequency Bands

Appendix A provides a chart of the electromagnetic spectrum that acts as a companion to the below table of frequency bands [Ref. 11].

Frequency	Letter Bands	Military Application Example	Competing Commercial
ELF/VLF/LF/MF 3 MHz and Below		Submarine Communications	N/A
HF 3-30 MHz		Tactical Long-Haul Communications	N/A
VHF 30-300 MHz		Tactical Short Range Communications	Little LEOs Public Safety
UHF 300-3000 MHz	L, S	Ground, Air and Satellite Communications	Cellular Services Mobile Satellite Services
SHF 3 GHz-30 GHz	C, X, S, Ku, Ka	Wide Band Satellite Services (GMF)	Fixed Satellite Services
EHF 30-300 GHz	Ka	Milstar	Unknown

Table 1 – Frequency Bands

A host of characteristics which include range, penetration, bandwidth, transportability and cost vary widely from band to band and make each particularly suitable (or unsuitable) for specific applications.

2. Terminology

The following terms form the foundation of spectrum management and are therefore provided. More comprehensive listings of related terminology are available in the *Manual of Regulations and Procedures for Federal Radio Frequency Management* [Ref. 12] and in Department of Defense (DoD) Directive 4650.1 *Management and Use of the Radio Frequency Spectrum* [Ref. 13].

Allocation (of a frequency band): Entry in the *Table of Frequency Allocations* of a given frequency band for the purpose of its use by one or radiocommunication services [Ref. 9]. Designation of frequency bands for performing specific functions and services [Ref. 14].

Assignment: Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions [Ref. 9].

Spectrum Certification: A process to determine and certify that electromagnetic (EM) frequencies, necessary for a system under procurement to accomplish its function, will be obtainable for the intended area of operation [Ref. 15].

Spectrum Management: Planning, coordinating, and managing use of the electromagnetic spectrum through operational, engineering, and administrative procedures, with the objective of enabling electronic systems to perform their functions in the intended environment without causing or suffering unacceptable interference [Ref. 15].

Table of Frequency Allocations: The comprehensive official listing of frequency allocations which includes international, US government, and US non-government

allotments. The *Table of Frequency Allocations* is contained within chapter four of the *Manual of Regulations and Procedures for Federal Radio Frequency Management* [Ref. 12].

C. PIONEERING THE FUTURE SPECTUM REQUIREMENTS OF JV 2010

The body of this research will address the challenges facing the acquisition and management of *JV 2010's* demanding spectrum requirements through a review of spectrum regulatory agencies and procedures at the international, national, and DoD levels. Through an understanding of global spectrum acquisition and management, a concrete perspective can be gained for future *JV 2010* system developers.

II. INTERNATIONAL AND FEDERAL SPECTRUM MANAGEMENT

A. THE INTERNATIONAL TELECOMMUNICATIONS UNION

1. General

The *International Telecommunications Union* (ITU) is the international body responsible for "international frequency allocations, worldwide telecommunications standards and telecommunication development activities." [Ref. 12] As discussed in Chapter I, the ITU is a specialized agency of the UN and is composed of over 185 countries as voting *Members*. Public and private organizations may also join the ITU as Sector members ("small-m"). There are currently 400 Sector members who may participate in Union activities and act in an advisory role. Sector members do not have voting rights.

Although countries retain the absolute right to manage and govern the entire radio spectrum within their borders, the ITU *Radio Regulations* have Treaty status and form the foundation of US national and international frequency management policies. The purpose of the Union, as stated in its constitution, is [Ref. 16]:

- To maintain and extend international co-operation between all members of the Union for the improvement and rational use of telecommunications of all kinds…
- To promote the development of technical facilities and their most efficient operation with a view to improving the efficiency of telecommunications services…
- To promote the use of telecommunications services with the objective of facilitating peaceful relations.
- To harmonize the actions of Members in the attenuation of these ends.

2. ITU Radio Regulations

The ITU *Radio Regulations* detail the agreements and procedures regulating (1) the allocation of frequency bands to services, (2) international frequency registrations, and (3) various "technical measures that have been given mandatory force in order to increase the efficiency with which the radio spectrum can be used." [Ref. 16] These regulations include the ITU *Table of Frequency Allocations* (ITFA). Table 2 provides a sample extract from the ITAF.

34 Frequency allocation

kHz
415 – 1 606.5

Allocation to Services		
Region 1	Region 2	Region 3
415 – 435 AERONAUTICAL RADIONAVIGATION / MARITIME MOBILE / 470 465	415 – 495 MARITIME MOBILE 470	
435 – 495 MARITIME MOBILE 470 Aeronautical Radionavigation 465 471	469 471	
495 – 505	MOBILE (distress and calling) 472	
505 – 526.5 MARITIME MOBILE 470 / AERONAUTICAL RADIONAVIGATION / 475	505 – 510 MARITIME MOBILE 470 471	505 – 526.5 MARITIME MOBILE 470 / AERONAUTICAL RADIONAVIGATION / Aeronautical Mobile Land Mobile
	510 – 525 MOBILE AERONAUTICAL RADIONAVIGATION	
465 471 474 475 476	525 – 535 BROADCASTING 477 AERONAUTICAL RADIONAVIGATION	471
526.5 – 1 606.5 BROADCASTING		526.5 – 535 BROADCASTING Mobile 479
	535 – 1 605 BROADCASTING	535 – 1 606.5 BROADCASTING
478		

Table 2 – ITU Table of Frequency Allocations, Sample

The ITAF, which is found in Article 8 of the *ITU Radio Regulations*, serves as a comprehensive listing of allocations from 9 KHz to 275 GHz.

a. Allocations and Services

The ITAF's principal elements include *allocations*, *services*, and *regions*. A radiocommunication service, as defined by the ITU *Radio Regulations,* is "a service involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes." There are currently 33 administrative services defined by the ITU. The ITU "service" concept is a regulatory issue which is important to government and military spectrum planners due to its consistent utilization throughout all echelons of frequency management. Table 3 lists several of the more common ITU services, their station class, and station description as listed in the NTIA *Manual*.

* Note: NTIA symbols are shown due to their use in US documents

Service	Station Class*	Station
Broadcasting	BC BT	Broadcasting (Sound) Broadcast (TV)
Fixed	FX FXD	Fixed Telecommand Fixed
Fixed Satellite	EC TC	Space Earth
Mobile	ML FA MA	Land Mobile Aeronautical Aircraft

Table 3 – ITU Services and Station Classes

b. Global Regions

Some, but not all, of the frequency allocations designated by the ITU have been allocated to services by region vice globally without boundary [see Fig. 1]. This practice was instituted on historical practicality based on the differing needs of each region and on the desire to share frequency allocations when cross-region interference was determined to be unlikely. Based on past agreements, "these regional allocations exist in the LF, MF, VHF, UHF, and SHF bands and currently raise many sharing problems now that space radio systems operate in many parts of the spectrum." [Ref. 16] Spectrum planners familiar with their own regional allocations may find that, once deployed, their radio systems are either unauthorized or susceptible to unexpected and detrimental interference. This situation can only be avoided through a successful and comprehensive system certification as discussed in Chapter IV.

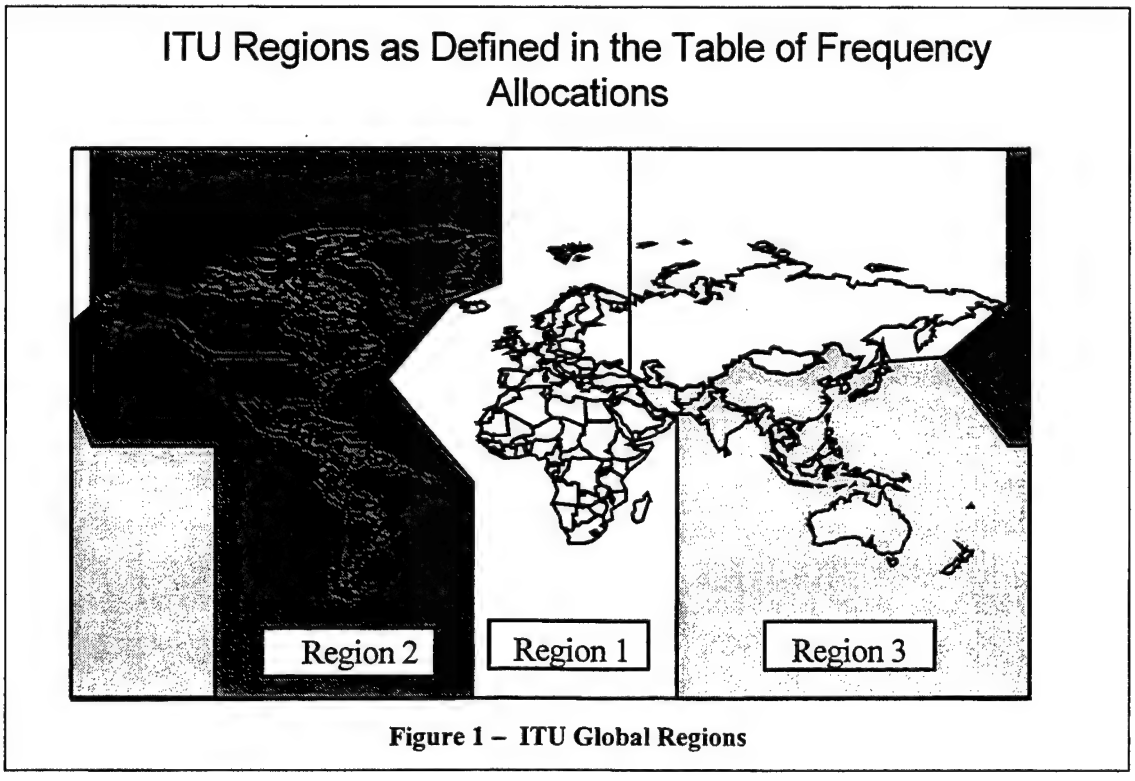

Figure 1 – ITU Global Regions

c. The World Radio Conference

The World Radio Conference (WRC) provides the means for ITU members to initiate changes to the ITU *Radio Regulations*. The WRC convenes every two years with the general scope of each conference's agenda being approved four years in advance. At a minimum, conference agenda items must be submitted to the ITU two years in advance of a conference. From initial notification to formal change, modifications of the *Radio Regulations* and/or the ITAF can be expected to take from four to six years. For US interests, the WRC is attended by individuals from the NTIA and the FCC.

d. International Frequency Assignments and the International Frequency Register

Although the allocations provided by the ITAF serve to provide guidance for the usage of specific bands within the ITU regions, often a more specific *assignment* is required in order to prevent interference by reserving certain frequencies. Within the ITU, the *International Frequency Registration Board* (IFRB) manages the list of frequency assignments and geostationary satellite orbital positions known as the *Master International Frequency Register* (MIFR) [Ref. 10]. As previously discussed, all ITU Member-nations are free to utilize, assign, and regulate allotted spectrum within their boundaries as they so determine. If a planned assignment is expected to cause interference beyond national boundaries, or if the assignment is for international use, the administration must apply to the IFRB for inclusion into the MIFR. The more important details of the MIFR are published twice annually by the ITU as the *International Frequency List* (IFL). A *Weekly Circular* is also published containing the full information on all new frequency assignment notifications [Ref. 16].

e. US National Assignments

With few exceptions, the ITU's regulations and allocations as ratified by the US government provide the framework for our national spectrum assignments. International border issues *within* our global region are resolved by international treaties which address co-region spectrum allocations. Several such agreements between the US, Canada, and Mexico are detailed in the NTIA *Manual*. The US Congress plays a critical role in determining the distinction between our nation's assignments as being categorized for either Government or non-Government use and regulation. The amended Communications Act of 1934 grants coequal authority to the FCC and the NTIA for the management of their commercial and federal spectrum domains, respectively. Within the approximately 800 bands spanning the entire 0 to 300 GHz allocated range, the US government has exclusive use of 1.4 percent, non-government users have exclusive use of 5.5 percent, and the remaining 93.1 percent is shared. Considering only the lucrative spectrum from 0 to 30 GHz, government exclusive allocations account for only 7 percent, non-government for 30 percent, and the remainder (63 percent) is shared [Ref. 17].

B. US SPECTRUM MANAGEMENT AGENCIES

1. The Federal Communications Commission

The FCC is the senior federal regulatory agency for all *non-governmental* US domestic telecommunications activities. Within the FCC, *the Wireless Telecommunications Bureau* is responsible for "all FCC domestic wireless telecommunications programs and policies, except those involving satellite communications or broadcasting, including licensing, enforcement, and

regulatory functions." [Ref. 18]. The *International Bureau* of the FCC is responsible for all non-government satellite communications issues.

The FCC plays a critical role in the WRC through its representation of US interests at the international level. In preparation for WRC-2000, the FCC is conducting technical analysis and preparing proposals with emphasis on the following subject areas: Non-geosynchronous orbit, fixed satellite service (NGSO-FSS)/geostationary orbit fixed satellite service (GSO-FSS) sharing issues; mobile satellite service (MSS) issues; spectrum allocation between 35 and 50 GHz; terrestrial issues; inter-satellite service links; maritime and aeronautical issues; broadcasting-satellite service (BSS) plan issues; and high frequency broadcast (HFBC) planning issues [Ref. 19]. The FCC works closely with the NTIA on WRC issues before each conference to develop common positions and joint proposals.

It is unlikely that military spectrum planners would require direct interaction or coordination with the FCC due to the services provided by the NTIA and the clear separation between governmental and non-governmental allocations.

2. The National Telecommunications Information Agency

a. General

The NTIA is an agency within the US Department of Commerce and is "the Executive Branch's principal voice on domestic and international telecommunications and information technology issues and, in this role, frequently works with other Executive Branch agencies to develop and present the Administration's position on these issues. In addition, the NTIA also manages the Federal use of the spectrum." [Ref. 20]

b. The Interdepartment Radio Advisory Committee

Chartered within the NTIA, the *Interdepartment Radio Advisory Committee* (IRAC) performs the basic functions of "assisting the Assistant Secretary in assigning frequencies to US Government radio stations and in developing and executing policies, programs, procedures, and technical criteria..." [Ref. 21] As shown in figure 2, The IRAC is composed of representatives from US federal departments and agencies and is organized into subcommittees which assist the NTIA in a variety of areas including: spectrum planning, policy development, WRC preparation, and international liaison with the ITU [Ref. 21]. The US Defense Department is represented within the IRAC by service representatives from the Army, Navy, Air Force and Coast Guard. The *Military Assignments Group* (MAG) of the IRAC is chaired by the Department of the Air Force and is concerned primarily with frequency assignment actions within the 225-328.6 and 335.4-399.9 MHz bands. Other military spectrum concerns are addressed within the appropriate IRAC subcommittees [Ref. 12].

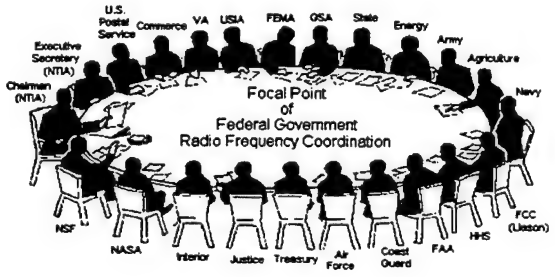

Figure 2 – IRAC Members

C. THE NATIONAL TABLE OF FREQUENCY ALLOCATIONS AND THE GOVERNMENT MASTER FILE

The *National Table of Frequency Allocations* is composed of the US *Government Table of Frequency Allocations* and the FCC *Table of Frequency Allocations*. Chapter IV of the NTIA *Manual* contains a detailed listing of both the International and National Tables of Frequency Allocations. Appendix B is provided as a sample page from this listing [Ref. 12]. Similar to the ITU's ITAF, when more than one service is allocated within a band, the services are designated as either PRIMARY, /PERMITTED/, or Secondary. The NTIA Manual classifies the relative status of these services as follows:

> Primary and permitted services have equal rights, except that, in the preparation of frequency plans, the primary service, as compared with the permitted service, shall have prior choice of frequencies. Secondary services are on a non-interference basis to the primary or permitted services [Ref. 12].

The allocations outlined in the National Table serve as a guide for the fulfillment of frequency assignments as required for domestic mission requirements. In order to request that a frequency be assigned for use, the requesting agency files an application with the NTIA, Office of Spectrum Management (OSM), for consideration by the Frequency Assignment Subcommittee (FAS) of the IRAC. If approved, the assignment is listed in the *Government Master File* (GMF) which is updated weekly. All current Government assignments are maintained in the GMF. The GMF is available to Federal agencies from the NTIA in CD-ROM format [Ref. 12].

D. FEDERAL SPECTRUM REALLOCATION ISSUES

What has historically been an area of regulation slow to change, US spectrum policy in recent years has become dynamic, unpredictable, and highly contested. The demands of new telecommunications technology have saturated the non-Governmental allocations and increasing requirements for commercial RF spectrum are inevitable. Realizing the revenue potential of domestic assignments, large segments of Governmental bands are planned to be, or have been transferred to the non- Governmental (FCC) sector and "allocation debates between the NTIA and the FCC are now punctuated by Congressionally mandated reallocations and auctions." [Ref. 22] A recent example of such policy is Title III of the Balanced Budget Act of 1997. Title III requires that at least 20 MHz of Federal use spectrum below 3 GHz be transferred to the FCC for assignment to non-Federal users. These reallocations have been submitted to Congress and become effective in stages between January 1999 and January 2008. Prior to Title III, the Omnibus Budget Reconciliation Act of 1993 reallocated 235 MHz to new spectrum-based technologies [Ref. 23]. To put the value of commercial frequencies in perspective, the *entire* US cellular industry operates on 50 MHz of spectrum [Ref. 24]. Unexpected, near-term reallocations are of significant concern to the Defense Department. Spectrum relocation costs for military telecommunications assets are predicted to "exceed one billion dollars assuming equipment can be retuned without extensive modification or replacement." [Ref. 23] If system-wide replacements are required, these costs will be significantly higher. Table 4 shows the minimum projected cost for adjustment to spectrum losses created by Title III.

NTIA Administrator Larry Irving summarized the challenge ahead with his remark:

"...while the recent auction activity has made many aware of the price of spectrum, there are still too few who understand the value of spectrum." [Ref. 22]

Summary of Preliminary Federal Reallocation Costs

Federal Agency	Estimated Reallocation Cost
Department of the Army	$260 million
Department of the Navy	$251 million
Department of the Air Force	$520 million
Federal Aviation Administration	$10 million
Department of Energy	$2.1 million
Department of Interior	$1.76 million
Department of Justice	$7 million
Department of the Treasury	$3.5 million
National Aeronautics and Space Administration	$520,000
United States Information Agency	$100,000
Total	**$1.056 billion**

Table 4 – Summary of Federal Reallocation Costs

E. CONCLUSION

International and National spectrum management is a complex and dynamic regulatory process essential to US military telecommunications interests. In this new era of rapid Federal reallocation and regulatory change, acquisition professionals and C4I planners are faced not only with new opportunities but with the potential for costly capability losses. Long-range planning, close coordination with the NTIA, and the exploration of commercial options will be essential in guaranteeing military users adequate spectrum for the realization of *Joint Vision 2010.*

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III. DEPARTMENT OF DEFENSE SPECTRUM MANAGEMENT AGENCIES AND RESPONSIBILITIES

The international and US policies defined by the ITU, the FCC and the NTIA provide the foundation for, and guiding principles of, our national military spectrum resources. Today over 85 percent of our current force structure is based in the continental US (CONUS) [Ref. 22]. Military relocation and the rapid acquisition of spectrum-dependent technology, combined with an insatiable demand for available frequencies from commercial industry, has brought the issue of Federal spectrum to the forefront of government debate. As within the civil sector, military IT assets are increasingly more efficient, less expensive, and have become heavily reliant on RF spectrum access. The distinction between deployable military C4I equipment (a.k.a. "green gear") and commercial equipment used to support military facilities and infrastructure has blurred with the recent explosive expansion of both technologies. What was once a fixed, available, and transparent asset, routine military RF spectrum access has now become a precious, contentious commodity requiring active management and flexible long-range planning. Overseas, the worldwide realization of commercial spectrum opportunities has imposed unprecedented new restrictions on operational access. Despite the urgency, temptation, or level of conflict, a disregard for host nation (or even hostile nation) allocations is likely to result in potentially extreme and debilitating interference within US systems. Even in the most austere and seemingly undeveloped environments, the proliferation of foreign military satellites and geostationary commercial MSS networks have ensured the likelihood of interference within our terrestrial systems. Thus the need for detailed frequency management and analysis within the acquisition, strategic planning, and operational community is now more critical to US military interests than ever before. Recent sweeping *Defense Reorganization Initiatives* have sought to

streamline and consolidate the agencies and policies which address spectrum management. These agencies, their responsibilities and their relation to one another are the subject of the remainder of this chapter.

A. RELATIONSHIPS AND RESPONSIBILITIES WITHIN THE DEPARTMENT OF DEFENSE

Although the agencies discussed within this chapter may appear to perform redundant roles within the DoD, these agencies and their subsequent duties are separated by either (1) hierarchical levels of *influence* and *authority* or (2) by basic *functional areas of responsibility.* An agency's influence is centered at either the *Departmental* policy level, the *Strategic* level, or the *Operational* level. *Tactical* Frequency management is also performed by individual units but this level of detail is not addressed in this document. Each level's directives and policies are subsequently reviewed by subordinates, further detailed (as required), and implemented. Functional responsibilities are related to possible combinations of acquisition, doctrine and directives, analysis, and operational support. Figure 3 portrays one interpretation of the *general* hierarchy and coordination observed by the principle DoD spectrum management agencies [Ref. 14]. These relationships are not rigid and often tasks, policies, or analysis are assumed by the agency best equipped to support the requirement. Recent Defense Reform-driven restructuring has created an expected redefinition of each agency's roles characterized by a period of mission exploration, redundancy, and gaps. As these roles are further defined and focused, the demands of emerging technology has ensured that new functional responsibilities will remain unclear as the Department strives to associate these duties with the agency best prepared to respond to these

needlines. Fortunately, it appears that redundancy, rather than deficiency, is the current state of affairs as the Department reaches equilibrium throughout the spectrum management community.

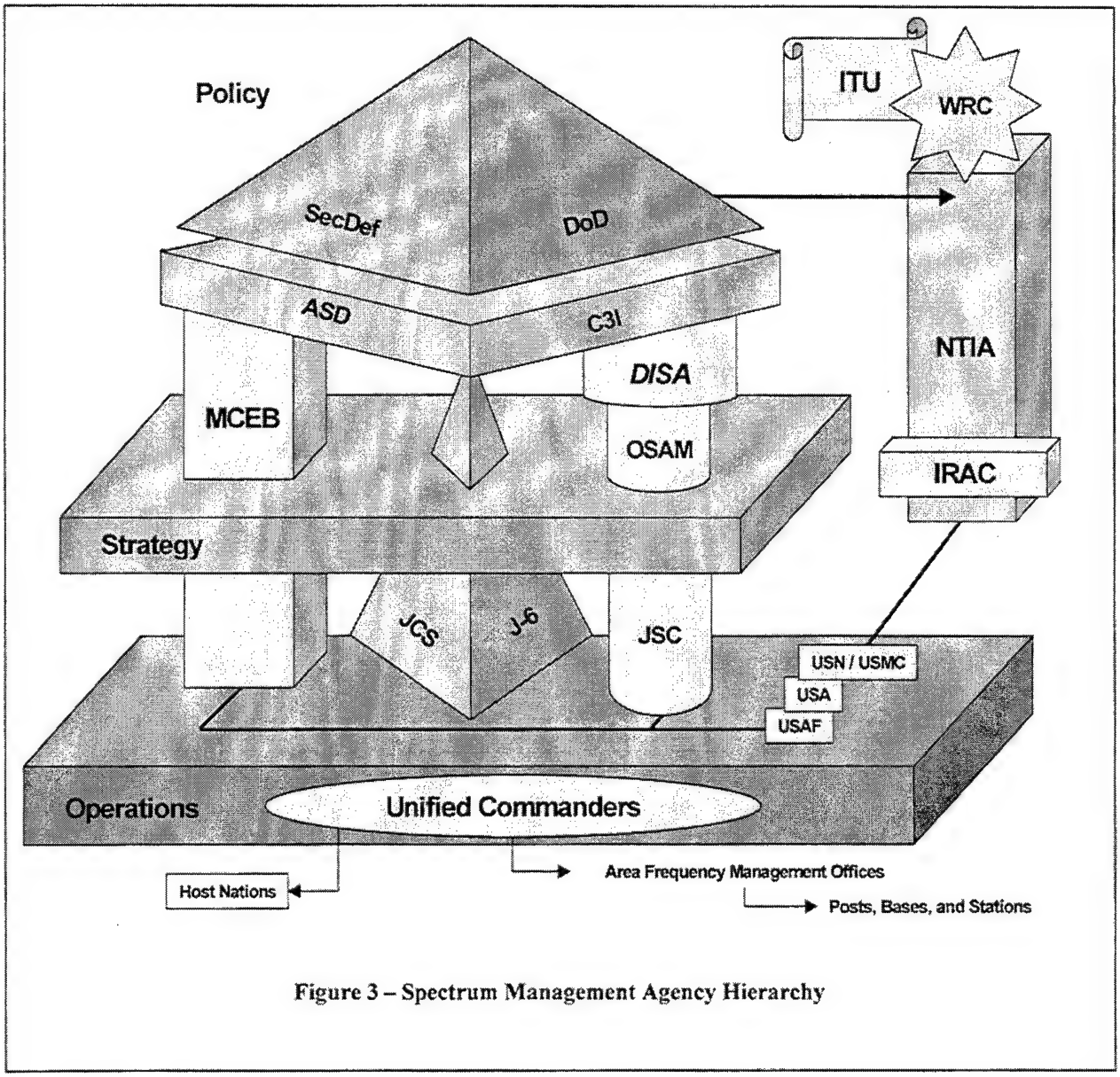


Figure 3 – Spectrum Management Agency Hierarchy

B. SENIOR SPECTRUM MANAGEMENT AGENCIES WITHIN THE DEPARTMENT OF DEFENSE

1. Office of the Assistant Secretary of Defense, Command, Control, Communications and Intelligence

The Office of the Assistant Secretary of Defense, Command, Control, Communications and Intelligence (ASD C3I) is at the top of the DoD spectrum policy pyramid and operates at the policy level of spectrum management. ASD C3I is the principle staff assistant to the Secretary of Defense for the development, oversight, and integration of DoD policies related to the Department's strategy of *Information Superiority* [Ref. 25]. Figure 4 displays the ASD C3I organization.

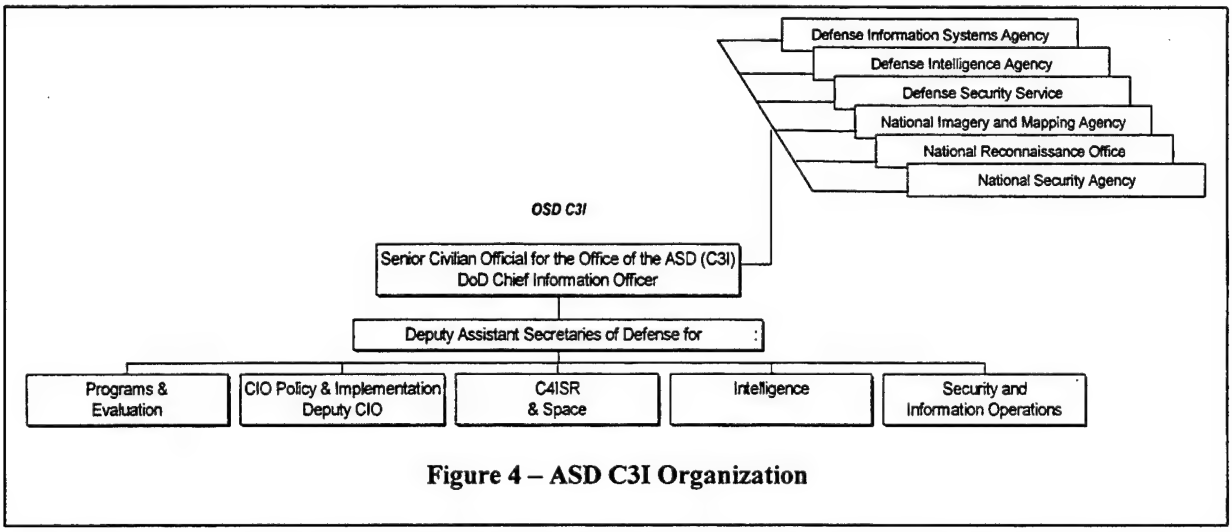


Figure 4 – ASD C3I Organization

The ASD C3I functions include information management, C2, communications, information operations, security, space systems policy, intelligence, surveillance, and reconnaissance. The ASD C3I also serves as the Department's *Chief Information Officer* (CIO).

ASD C3I supervises the Department's spectrum management efforts by publishing broad policy directives, acquisition supervision and detailed support through it's Executive Agent, The Defense Information Systems Agency.

The Defense Information Systems Agency

A key component of ASD C3I is the *Defense Information Systems Agency* (DISA). DISA is the DoD's principal manager of the vast *Defense Information Infrastructure* (DII) and as such addresses spectrum issues at all levels of influence. The DII is composed of the *Defense Information System Network* (DISN), the *Defense Message System* (DMS), the *Global Command and Control System* (GCCS), and the *Global Combat Service Support System* (GCSS). DISA has defined its mission as:

> To plan, engineer, develop, test, manage programs, acquire, implement, operate, and maintain information systems for C4I and mission support under all conditions of peace and war. [Ref. 26]

To accomplish this mission, DISA is organized into eight Organizational Staff Sections, D1 through D8, with responsibilities which include Manpower, Program Integration, Operations, Acquisition, Plans and Policies, Engineering, Requirements Analysis, and Modeling and Simulation.

a. The DISA Office of Spectrum Analysis and Management

The D3, Operations, section contains the *DISA Office of Spectrum Analysis and Management* (OSAM). The OSAM mission is defined as:

> The Office of Spectrum Analysis and Management (OSAM) is the focal point within the DoD as the technical office of expertise for spectrum management issues. They coordinate analytical support, ensure consistent enforcement of spectrum management policy and procedures DoD-wide, and position DoD to ensure spectrum access into the 21st Century. [Ref. 27]

OSAM is best characterized as an interpreter of policy for the development of strategy assisted by operational input. Within this role, OSAM performs such functions as technical analysis of legislation affecting Federal spectrum, spectrum certification assistance, requirements analysis, international notification of new DSCS satellites, and coordination of the development of new spectrum management technologies. In order to facilitate coordination and cooperation, each service's senior frequency management agency is collocated with OSAM. These offices include the Naval Electromagnetic Center (NAVEMCEN), the Army Communications Electronics Command (CECOM), and the Air Force Frequency Management Office (AFFMO).

b. The Joint Spectrum Center

As a DISA Executive Agent and Field Organization, the Joint Spectrum Center (JSC) is tasked with ensuring "the effective use of the electromagnetic spectrum in support of national security and military objectives." [Ref. 28] As the technical arm of DISA's spectrum effort, JSC validates strategic concepts through the active support of operational efforts. A combination of extensive resources, experienced expert personnel, and comprehensive databases have established JSC as the Defense Department's most capable spectrum support agency. The JSC *Core Competencies* are listed as: [Ref. 29]

- ***Spectrum Planning*** – supporting the warfighter's spectrum requirements by assisting in spectrum policy planning, spectrum certification and frequency assignment planning.
- ***System Acquisition Support*** – providing the most cost-effective approaches to ensuring that warfighter communications-electronics systems will function effectively and compatibly in their intended electromagnetic environment.
- ***Modeling and Simulation*** – incorporating electromagnetic environmental effects (E^3) into DoD models and simulations used for test, training and acquisition.

- ***Operational Support*** – providing direct spectrum management and interference resolution support to the warfighting CINCs and Military Departments.
- ***Information Systems*** – supplying the databases, E^3 tools, and battlefield spectrum management systems used by our warfighting forces.

JSC is responsive to support requests from all echelons within the US military. Component representatives from each service branch are assigned to JSC and provide direct liaison to unit customers at all levels of command while supervising the completion of product requests. Examples of JSC product support include: multi-service design and development of Identification, Friend or Foe (IFF) systems, US Army RAH-66 Comanche electromagnetic compatibility (EMC) services, US Navy EM interference analysis for the *Pointer* unmanned aerial vehicle (UAV), US Marine Corps Assault Amphibious Vehicle (AAV) cosite interference resolution, and ongoing US Air Force support for the Global Positioning System's (GPS) EMC/EMI analysis [Ref. 29].

2. The Chairman of the Joint Chiefs of Staff, J-6

The Directorate for Command, Control, Communications and Computer Systems (J-6) within the Joint Staff has the following mission: [Ref. 30]

> The Director for Command, Control, Communications and Computer (C4) Systems (J-6) is charged with providing advise and recommendations to the Chairman of the Joint Chiefs of Staff and to the Joint Chiefs of Staff, as directed by the Chairman, on C4 matters. J-6 will develop policy and plans, monitor programs for joint C4 systems, and ensure adequate C4 support to CINCs, NCA, and all joint warfighters for joint and combined military operations. J-6 will lead the C4 community, conceptualize future C4 systems architectures, and provide direction to improve joint C4 systems.

Resident primarily within the strategic layer of spectrum management, the JCS J-6 transcends each layer based on a variety of functional responsibilities. Reference 59 details the forty-three

specific functions of the JCS J-6, many of which involve executive oversight of C4 systems and policies involving the uses of RF spectrum. One of these functions specifically tasks the J-6 to serve as the Chairman of the *Military Communications-Electronics Board* (MCEB).

3. The Military Communications-Electronics Board

The MCEB serves to coordinate policy and strategy within the DoD by providing a flexible, well represented forum to address C4I-related issues. Tasked by the ASD C3I to chair the Board, the CJCS J-6 is responsible to: [Ref. 31]

- Obtain coordination among DoD components, between the Department of Defense and other Governmental Departments and Agencies, and between the Department of Defense and the representatives of foreign nations as to matters under MCEB jurisdiction.
- Provide guidance and direction to the DoD components.
- Furnish advise and assistance as requested.

Although administratively supported by the CJCS J-6, the MCEB is perhaps the Defense Department's most diverse and well represented forum regarding spectrum management policies and acquisition. As a "steering committee" vice a standing agency, the MCEB operates across, and is represented by, each echelon of responsibility. This cooperative and flexible organization is characterized by an intentionally unrestrictive and overarching charter which allows for the resolution of issues that might otherwise be hindered by compartmentalization. The Board is formally composed of the CIOs from the Navy, Army, Air Force, Marine Corps and Coast Guard, and the Directors of DISA, NSA, and DIA. The Board's spectrum-related functions include inter-Department conflict resolution, policy guidance and development for RF management, and the development and review of joint and allied C-E operating procedures [Ref.

31]. The MCEB also is responsible for managing the *Frequency Resource Record System* (FRRS). As defined in Joint Publication 6-02, FRRS includes a frequency assignment database, a proposal preparation and validation capability and proposal coordination and approval notification." [Ref. 32] The FRRS frequency assignment database represents the military equivalent of the Federal GMF. The MCEB's specific role in program acquisition is discussed in Chapter Four.

C. THE UNIFIED COMBATANT COMMANDS

The operational military forces and assets of the United States are organized by global responsibility into nine distinct *Warfighting* Commander-in-Chiefs (CINCs) or Unified Combatant Commands.

> The operational chain of command runs from the President to the Secretary of Defense to the Commanders of the Unified Combatant Commands. The Chairman of the Joint Chiefs of Staff functions within the chain of command by transmitting to [the Commanders] the orders of the President or the Secretary of Defense. [Ref. 33]

Functioning at the operational level of spectrum management, each CINCs J-6 staff section contains a *Joint Force Commander's Frequency Management Office* (JFC FMO) which is responsible for spectrum management throughout the CINCs *Area of Operations* (AO) [Ref. 32]. To assist in the administration of these duties, Area Frequency Management Offices (AFMO) support the requirements and requests of forces, posts, bases and stations within their sub-region. Below the AFMO, each major post, base and station also has a frequency management section which, in turn, is responsible for the daily spectrum-related operations aboard their facility.

Finally, the major commands stationed aboard a particular base (such as II MEF at Camp LeJeune, or XVIII Airborne Corps at Fort Bragg) have an assigned *Frequency Manager* within the Commanding General's (CG) G-6 (Signal or Comm-Elec) section for the *tactical* management of frequency assignments and policy. Below this level, the duties extend down to the tenant brigades, wings, and/or regiments. Frequency management responsibilities at this echelon are normally handled as an additional duty by the unit's signal officer (S-6).

D. REFERENCES AND DOCTRINAL PUBLICATIONS

The following directives and publications represent the principal documents outlining Defense Department spectrum management and policy:

- DoD Directive 4650.1 – Management and Use of the Radio Frequency Spectrum
- DoD Directive 5100.35 – Military Communications Electronics Board
- CJCSI 3220.01 – Electromagnetic Spectrum Use in Joint Military Operations
- Joint Publication 6-02 – Joint C4 Principles, Planning and Management

IV. THE SPECTRUM CERTIFICATION PROCESS

A. INTRODUCTION

State-of-the-art technological exploitation of the RF spectrum can hinge on antiquated treaties and allocations dating back to the dawn of international radio regulation. As discussed in the previous chapters, operational military employment of the RF spectrum is an end-state made possible by a successful, dynamic and comprehensive management, assignment, and allocation process. These processes must be linked and carefully coordinated to ensure that appropriate spectrum resources are available when and where required, and that our equipment assets are configured to take advantage of this availability. To accomplish this, the DoD-unique *Spectrum Certification* process is required for all planned systems entering the acquisition cycle. Spectrum certification is "a process to determine and certify that electromagnetic (EM) frequencies, necessary for a system under procurement to accomplish its function, will be obtainable for the intended area of operation." [Ref. 15] US military equipment spectrum certification is challenged by the fact that tactical RF equipment is deployable world-wide and as such is subject to a dizzying array of international allocations. This challenge brings to light the utility of the ITU's regional allocations by band. This agreement has sectionalized the RF spectrum into common usage segments simplifying the general identification of bands by service. Military acquisition professionals and contractors are ultimately faced with three choices for meeting the RF demands of their planned system:

(1) Utilize existing DoD allocated and approved spectrum in a traditional, assigned role
(2) Develop new frequency schemes that promise to not interfere with existing allocations and/or assignments
(3) Propose a change to national or international spectrum allocations and await resolution

The spectrum certification process is characterized by broad DoD guidance contained within the Federal Acquisition Regulations (FARs) and specific yet unique and disjointed Service regulations. Spectrum certification for new DoD systems requires, at a minimum, US military, Federal, and limited international approval as shown in Figure 5.

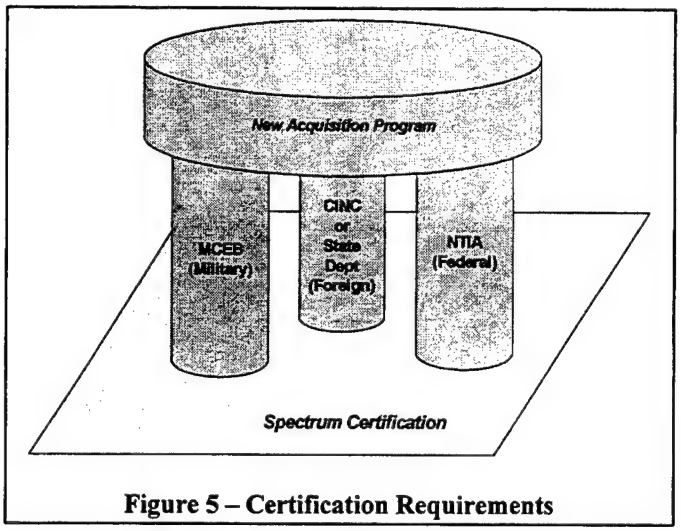


Figure 5 – Certification Requirements

In order to document, assess and revise current processes, OSAM has published the *Certification of Radio Frequency Dependent Systems* [Ref. 34]. This reference details each Service's current spectrum certification process and provides recommendations for revision. Specifically, OSAM's effort is striving to:

> *...integrate the existing service-specific Spectrum Certification processes into a single, efficient process, and to specify the technical infrastructure that must be acquired or developed support a future DoD common Revised Spectrum Certification Process..*

This chapter will summarize the *current* process within the US Navy and address subsequent issues associated with military spectrum certification.

B. FEDERAL REQUIREMENTS

Spectrum certification for military acquisition programs is addressed by the the Defense Department in DoD 5000.2-R *Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information Systems*. Further requirements are defined in *the DoD Federal Acquisition Regulation Supplement*. Combined with the specific procedures outlined in MIL-HDBK-237, the frequency allocation stages for an RF system are linked to a project's acquisition phases as shown in Figure 6. [Ref. 34]

At the Federal level, both the Defense Department and the NTIA are actively involved in this certification process also known as *J-12 process*.

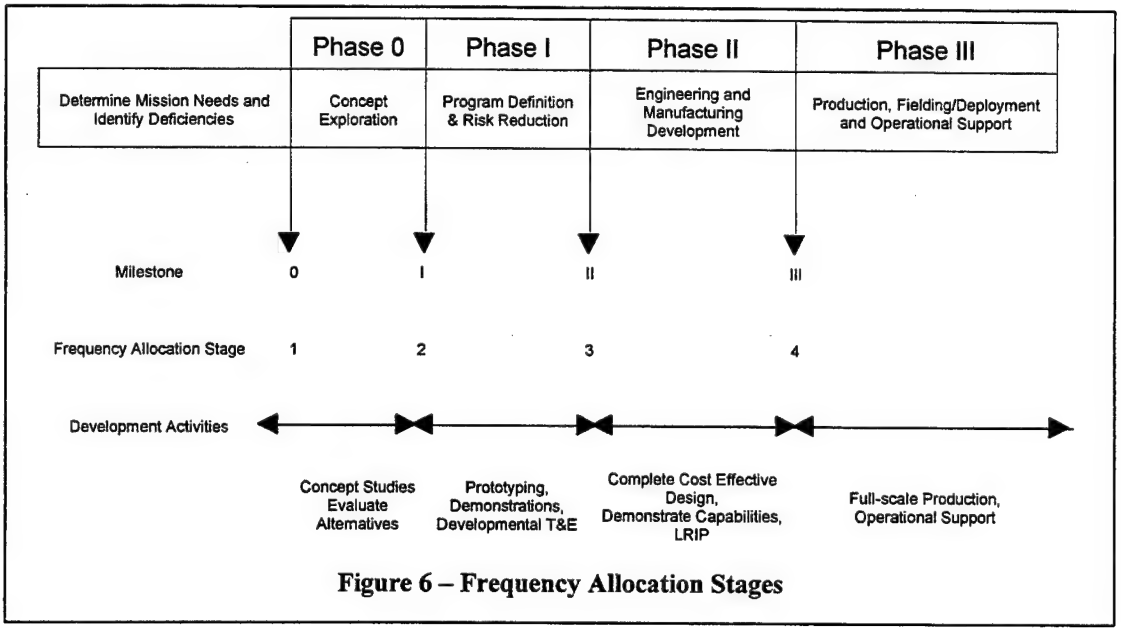


Figure 6 – Frequency Allocation Stages

1. The NTIA Review

Within the NTIA, the *Spectrum Planning Subcommittee* (SPS) of the IRAC is tasked with reviewing each system for electromagnetic compatability and potential interference. The IRAC's *Frequency Assignment Subcommittee* is responsible for the ultimate assignment within

US military allocated spectrum, if available and approved. The NTIA SPS submission represents the start of one significant evaluation within the overall certification process. Depending on the service branch, this submission may be pursued before, during, or after a submission is made to the MCEB's J-12 working group.

2. Defense Department Review

The MCEB J-12 *Permanent Working Group* reviews and screens new applications forwarded from the individual services. The application is then forwarded and screened by the MCEB *Frequency Panel* for further analysis, action, and ultimately, final consideration for certification. The MCEB also coordinates foreign reviews of the proposal through each Unified Combatant Commander's J-6 FMO. An overview of the certification process at the National level is shown in Figure 7. "Each host nation must certify that frequency support is available before a system can be deployed to that country." [Ref. 34] Foreign approval, combined with the MCEB certification represents two major milestones on the certification process.

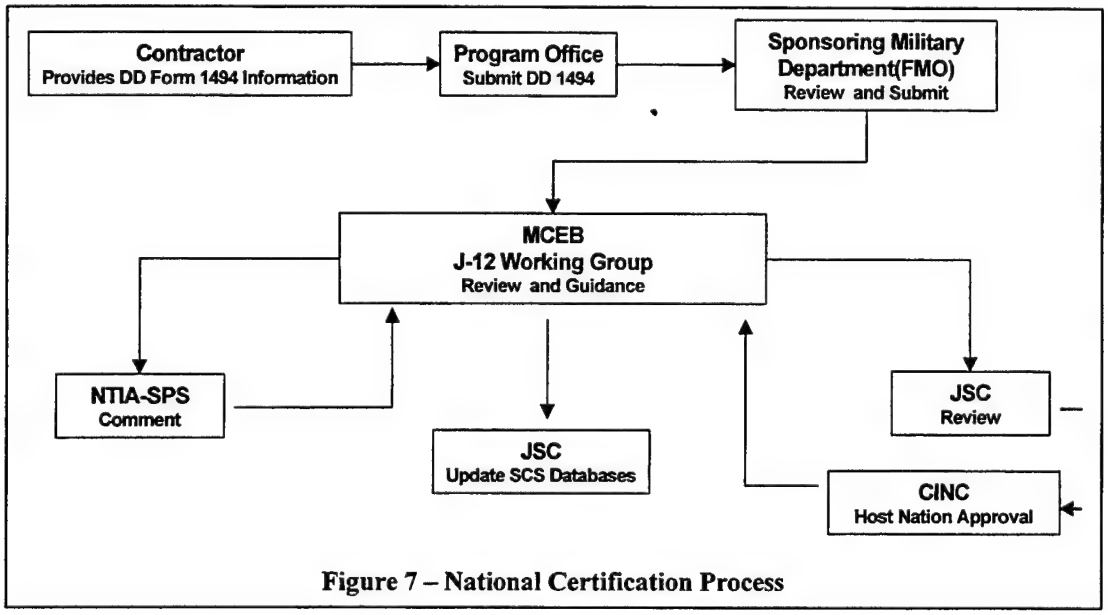


Figure 7 – National Certification Process

Throughout this evaluation, the JSC provides technical and EM compatability analysis in support of the J-12 process. Following a system's certification, the JSC adds the equipment's parameters to its *Space and Communications System* (SCS) databases.

C. THE NAVY J-12 PROCESS

As discussed earlier, Service policies for spectrum certification vary yet each must accomplish (1) Service internal authorization, (2) NTIA allocation and (3) MCEB allocation which includes foreign and host nation approval. The Navy J-12 process is outlined in Figure 8. OSAM's *Certification of Radio Frequency-Spectrum Dependent Systems* summarizes the Navy's process as follows:

> The Chief of Naval Operations, CNO OP-941F has approval authority for all Navy and Marine Corps systems. The Naval Electromagnetic Spectrum Center (NAVEMCEN) is CNO's agent in frequency spectrum matters, NAVEMCEN personnel represent the Navy on the J-12 Working Group and the SPS. Applications submitted to CNO are reviewed by NAVEMCEN and then submitted to the necessary reviewing agencies (J-12 WG, SPS, and MCEB for foreign coordination). Upon successful completion of all reviews, CNO forwards an approval letter to the submitting officer.

The Navy process as outlined above is reassessed throughout the acquisition cycle for each Frequency Allocation Stage. OPNAVINST 2400.20E defines this requirement:

> An allocation for frequency Allocation (DD 1494) will be prepared, marked for the correct stage of procurement, and submitted to CNO (OP-941F):
> - As early as possible during concept formulation (Stage One) and during demonstration and validation (Stage Two).
> - When equipment development progresses to a full-scale development stage...(Stage Three).
> - When procurement of a commercial equipment or system for military use is being planned (Stage Four).
> - When a change occurs in any of the stated conditions of electromagnetic parameters of an equipment for which a frequency allocation was previously approved, or pending approval...

The Navy's process effectively addresses the three requirements of (1) military (MCEB), (2) national (NTIA-SPS) and (3) international (host nation) approval for allocation. Although there

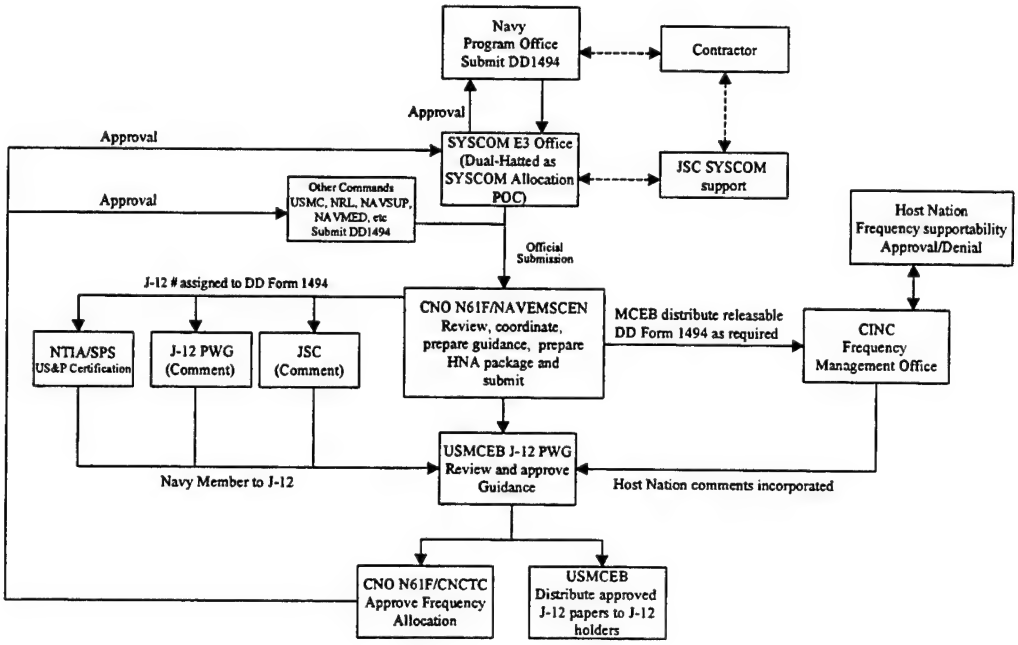


Figure 8 – US Naval Certification Process

is no clearly better or worse service certification process between the Navy, Army, and Air Force processes, the amount of effort expended by each service within their unique processes calls to question the overall efficiency at a Joint level as each broach national and international approval.

Perhaps the most accurate overview of our modern military's search for available spectrum in support of new acquisition programs is outlined within OPNAVINST 2400.20E:

> Normally, frequencies of operation for new equipment or systems are selected from bands allocated to the appropriate radio service or to similar systems. In certain cases, after due consideration for the protection of existing primary services and of the possible operational

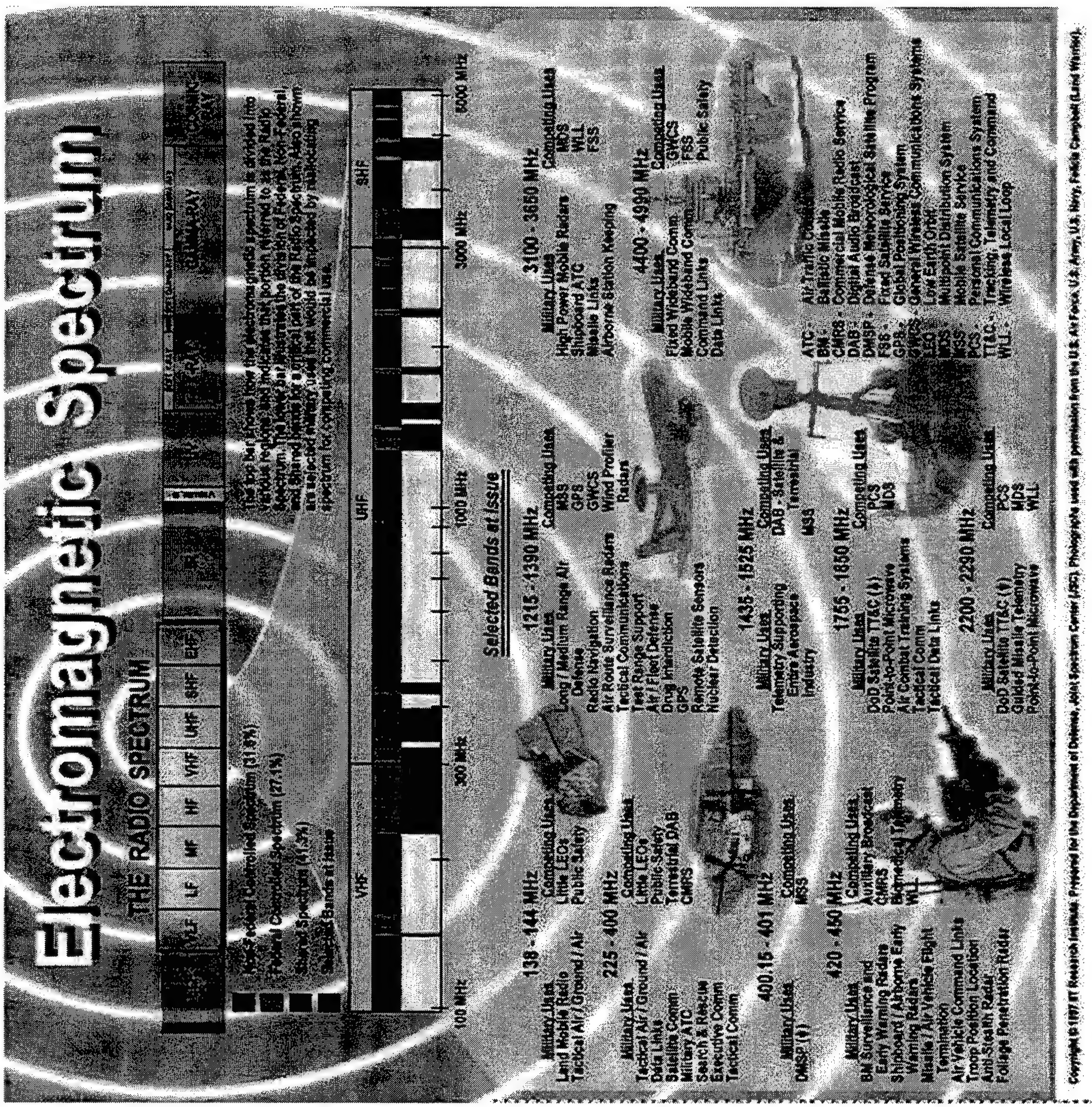
restrictions to the newly developed equipment, the developer may propose other frequency bands for operation. In such extraordinary circumstances, operational, technical, and economic justification must be provided with the allocation application. Technical justification must demonstrate that the proposed system will not degrade the electromagnetic compatibility of the current environment. Proposed out-of-band systems will always have secondary status and may only operate on a not-to-interfere basis (NIB) to established services. However, nothing in this instruction is intended to impede research toward the development of C-E systems that are necessary to increase the combat effectiveness of the USN or USMC.

D. SUMMARY

The Spectrum Certification process is the Defense Department's principal means of ensuring that the required spectrum resources will be available when and where they are needed to support future operational requirements. Expanding private sector needs, a dynamic regulatory environment, and targeted reallocations of Federal bandwidth are all significant factors to be considered by military telecommunications planners. Unlike most other natural and physical resources, spectrum can not be captured, commandeered, or subjected to rationing. Existing international commercial and civil assignments, particularly those that are space-based, are impervious to the needs of military operations. Due to their significant coverage and power, rather than challenged or ignored, these civil and foreign military assignments should be identified, respected, and avoided. For obvious reasons, the military Spectrum Certification process is now being reviewed and updated by not only OSAM but by all services and agencies involved in frequency management. As with acquisition reform, the military can no longer financially or operationally afford the long, inflexible, and arduous process of existing certification. For spectrum resources already allocated to military applications, a lack of active regulatory involvement could result in the proverbial "rug" being pulled out from under military

assets assumed to be secure in their assignments and availability. Only through a comprehensive understanding of, and involvement in, the issues, proposals, and politics of international spectrum allocation will the military be able to achieve the spectrum resources required for the 21st century and *JV 2010*.

APPENDIX A . ELECTROMAGNETIC SPECTRUM



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APPENDIX B. NTIA ALLOCATION TABLE EXTRACT

TABLES OF FREQUENCY ALLOCATIONS

INTERNATIONAL			UNITED STATES			
Region 1 MHz	**Region 2 MHz**	**Region 3 MHz**	**Band MHz**	**Government Allocation**	**Non-Government Allocation**	**Remarks**
267-272 FIXED MOBILE Space Operation (space-to-Earth) 641 643			267-322	FIXED MOBILE G27 G100		The FAA provides air traffic control communications to the military services on selected frequencies in this band.
272-273 SPACE OPERATION (space to Earth) FIXED MOBILE 641						
273-312 FIXED MOBILE 641						
312-315 FIXED MOBILE Mobile-Satellite (Earth-to-space) 641 641A						
315-322 FIXED MOBILE 641						
322-328.6 FIXED MOBILE RADIO ASTRONOMY 644			322-328.6	FIXED MOBILE 644 G27	644	The FAA provides air traffic control communications to the military services on selected frequencies in this band.
328.6-335.4 AERONAUTICAL RADIONAVIGATION 645 645A			328.6-335.4	AERONAUTICAL RADIONAVIGATION 645	AERONAUTICAL RADIONAVIGATION 645	

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